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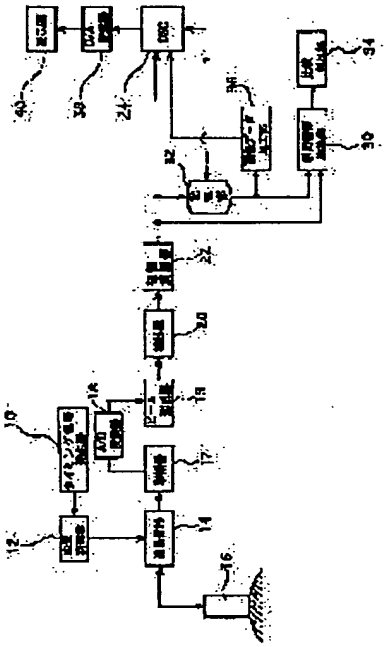
(54) ULTRASONIC DIAGNOSTIC DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To easily compare an image obtained at present with a reference image in the past by an ultrasonic diagnostic device.
SOLUTION: Display attributes such as hues and the like of a tomographic image in the past stored in a storing part 32 are converted by an image data processing part 36. For example, the colored reference image is superimposed with a monochrome image of interest presently obtained from a probe 16 at DSC 24 to be displayed on a display part 40 as an overlay image integrated into one image. Moreover, a correlation index calculation part 30 calculates a correlation coefficient of data between the image of interest and the reference image. If a comparator part 34 detects that the correlation coefficient has exceeded a threshold, the image of interest in the overlay image is kept at a standstill at an image similar to the reference image, and the image of interest at this time is stored in a storage part 32.



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CLAIMS

[Claim(s)]
[Claim 1] The ultrasonic diagnostic equipment carry out containing an overlay image generation means generate the overlay image on top of which a reference image storage means memorize the reference image based on the echo data of the past obtained by the transmission-and-reception wave of a supersonic wave, an attention image generation means generate an attention image based on the echo data obtained now, and said reference image and said attention image of each other laid identifiable, and a display means display said overlay image as the description.
[Claim 2] It is the ultrasonic diagnostic equipment characterized by making identifiable said reference image on which said overlay image generation means was put in the ultrasonic diagnostic equipment according to claim 1 using the hue, and said attention image of each other.
[Claim 3] It is the ultrasonic diagnostic equipment characterized by making identifiable said reference image on which said overlay image generation means was put in the ultrasonic diagnostic equipment according to claim 1 using brightness, and said attention image of each other.
[Claim 4] It is the ultrasonic diagnostic equipment which has a profile emphasis means to emphasize the profile of said reference image, in an ultrasonic diagnostic equipment according to claim 1, and is characterized by said overlay image generation means laying the reference image which had said profile emphasized on top of said attention image.
[Claim 5] It is the ultrasonic diagnostic equipment characterized by memorizing said reference image with which binarization of said reference image storage means was carried out in the ultrasonic diagnostic equipment according to claim 1.
[Claim 6] The ultrasonic diagnostic equipment carry out containing a reference image storage means memorize the reference image based on the echo data of the past obtained by the transmission-and-reception wave of a supersonic wave, an attention image generation means generate an attention image based on the echo data obtained now, and a correlation evaluation means compute the correlation index of said reference image and said attention image as the description.
[Claim 7] It is the ultrasonic diagnostic equipment which has the binarization means which carries out binarization of said reference image and said attention image, respectively in an ultrasonic diagnostic equipment according to claim 6, and is characterized by said correlation evaluation means computing said correlation index of said reference image by which binarization was carried out, and said attention image by which binarization was carried out.
[Claim 8] It is the ultrasonic diagnostic equipment which has a profile extract means to extract a profile from said reference image and said attention image, respectively, in an ultrasonic diagnostic equipment according to claim 6, and is characterized by said correlation evaluation means computing said correlation index based on the comparison between said profiles extracted from said reference image and said attention image, respectively.
[Claim 9] The ultrasonic diagnostic equipment characterized by having an index display means to display said correlation index on either of claim 6 to claims 8 in the ultrasonic diagnostic equipment of a publication.

[Claim 10] The ultrasonic diagnostic equipment characterized by detecting that said correlation index exceeded the predetermined threshold, and having an image storing means to store said attention image in a storage means in an ultrasonic diagnostic equipment given in either of claim 6 to claims 9.
[Claim 11] The ultrasonic diagnostic equipment characterized by detecting that said correlation index exceeded the predetermined threshold, and having an image frieze means to freeze said attention image whose animation is displayed by the display in an ultrasonic diagnostic equipment given in either of claim 6 to claims 10.
[Claim 12] The ultrasonic diagnostic equipment characterized by having a correlation evaluation means to compute the correlation index of said reference image and said attention image, and an image frieze means to freeze said attention image whose animation detects that said correlation index exceeded the predetermined threshold, and is displayed by the display in an ultrasonic diagnostic equipment given in either of claim 1 to claims 5.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the ultrasonic diagnostic equipment which can perform the comparison with the past observation result about an ultrasonic diagnostic equipment.
[0002]
[Description of the Prior Art] In the diagnosis by the ultrasonic image, the same part is compared among different patients, and investigating aging of the same patient's disease is performed. In order to enable a useful comparison in these cases, it is necessary to obtain the ultrasonic image in the same tomographic layer. It depends for the tomographic layer scanned by the supersonic wave not only on the location to which an ultrasound probe is applied but on the sense of the transmission-and-reception wave of a supersonic wave.
[0003] It is a difficult activity to inspect by making the same the degree of freedom of these plurality of a probe each time, and it is an activity which requires skill. While displaying the ultrasonic fault image (reference fault image) obtained by the past inspection with a still picture on the display screen of an ultrasonic diagnostic equipment as a policy which solves this difficulty, how to arrange to it and display the attention fault image which is an ultrasonic fault image under current inspection can be considered. Comparing two fault images on a screen, the tester who is a diagnostic-equipment user will change the contact location and sense of an ultrasound probe, and will search this approach for the conditions from which a desired fault image is obtained. According to this approach, the standard which judges whether it is that with which a tester can be satisfied of the conditions of a current ultrasound probe is obtained.
[0004]
[Problem(s) to be Solved by the Invention] However, by the approach of comparing two images which the **** arranged and were displayed, decision of the degree of coincidence of both images has the problem that a tester's load is large, at the problem of the place depending on qualitative decision of a tester being large, and requiring skill too, and its point.
[0005] This invention is made in view of the above-mentioned conventional technical problem, and the purpose is in making it easy to obtain an attention fault image with the value as a candidate for a comparison in the ultrasonic diagnostic equipment which diagnoses based on the comparison with a reference fault image.
[0006]
[Means for Solving the Problem] The ultrasonic diagnostic equipment concerning this invention contains an overlay image generation means generate the overlay image on top of which a reference image storage means memorize the reference image based on the echo data of the past obtained by the transmission-and-reception wave of a supersonic wave, an attention image generation means generate an attention image based on the echo data obtained now, and said reference image and said attention image of each other laid identifiable, and a display means display said overlay image.
[0007] According to this invention, the attention image made applicable to diagnostic piles up with the reference image obtained in the past diagnosis, is set, and is displayed. A reference image is an image

set as the comparison object of an attention image. The class will not be asked if an attention image and a reference image are images of the same kind. That is, for example, they may be a solid image besides a fault image, an M mode image, etc. Moreover, generally an attention image is not restricted in that case, although generated based on the newest echo data in the time of a diagnosis usually being performed. That is, current [of "the echo data obtained now" about an attention image / "current"] means the time of considering as the candidate for diagnostic, and means that it is at the separate diagnostic time as the echo data of a reference image here. According to the overlay image on top of which the reference image and the attention image were laid, a tester is shown both images unitary and it becomes easy for a tester to grasp the existence of a difference of both [these] images and extent.

[0008] It is the ultrasonic diagnostic equipment characterized by the suitable mode of this invention making identifiable said reference image which said overlay image generation means piled up using the hue, and said attention image of each other. Moreover, it is the ultrasonic diagnostic equipment characterized by other suitable modes of this invention making identifiable said reference image which said overlay image generation means piled up using brightness, and said attention image of each other.

[0009] Moreover, the suitable mode of this invention has a profile emphasis means to emphasize the profile of said reference image, and said overlay image generation means is an ultrasonic diagnostic equipment characterized by laying the reference image which had said profile emphasized on top of said attention image. By emphasizing a profile, a reference image becomes identifiable from an attention image.

[0010] In the ultrasonic diagnostic equipment concerning other this inventions, said reference image storage means memorizes said reference image by which binarization was carried out. A reference image is referred to in order to determine the contact location and sense of an ultrasound probe which acquire the echo data which generate an attention image. For that purpose, what is necessary is just to be able to specify the facies of the image which appears in a reference image fundamentally. According to this invention, the amount of data of the reference image stored in a reference image storage means is controlled, a reference image expressing the description of an image by carrying out binarization.

[0011] The ultrasonic diagnostic equipment concerning this invention contains a reference image storage means memorize the reference image based on the echo data of the past obtained by the transmission-and-reception wave of a supersonic wave, an attention image generation means generate an attention image based on the echo data obtained now, and a correlation evaluation means compute the correlation index of said reference image and said attention image.

[0012] According to this invention, the difference with a reference image and an attention image is quantitatively shown as a correlation index. A tester can adjust the contact location of an ultrasound probe, and the sense so that the correlation index may decrease. As a correlation index, although a correlation coefficient can be used, it is not necessarily restricted to it, for example.

[0013] In the ultrasonic diagnostic equipment of the suitable mode of this invention, it has the binarization means which carries out binarization of said reference image and said attention image, respectively, and said correlation evaluation means computes said correlation index of said reference image by which binarization was carried out, and said attention image by which binarization was carried out. The value which integrated with the value of the exclusive OR for every pixel of both images in the image field in addition to the correlation coefficient can be used as a correlation index in this mode.

[0014] The suitable mode of this invention has a profile extract means to extract a profile from said reference image and said attention image, respectively, and said correlation evaluation means is an ultrasonic diagnostic equipment which computes said correlation index based on the comparison between said profiles extracted from said reference image and said attention image, respectively.

[0015] Moreover, the ultrasonic diagnostic equipment concerning other this inventions is characterized by having an index display means to display said correlation index. According to this invention, the tester using equipment is shown a correlation index and a tester can judge similar extent of an attention image and a reference image based on the correlation index. For example, the digital readout of the correlation index can also be carried out on an image display device with an attention image, and it can also be displayed with the indicator displayed on CRT.

[0016] The ultrasonic diagnostic equipment concerning this invention is characterized by detecting that said correlation index exceeded the predetermined threshold, and having an image storing means to store said attention image in a storage means. According to this invention, the attention image which has a correlation index beyond a predetermined threshold, i.e., the attention image judged to be similar to the reference image, is recorded automatically. A tester can read the recorded attention image from a storage means, and can perform the diagnosis based on the comparison with a reference image etc.
[0017] The ultrasonic diagnostic equipment concerning this invention is characterized by detecting that said correlation index exceeded the predetermined threshold, and having an image frieze means to freeze said attention image whose animation is displayed by the display. If the attention image which has a correlation index beyond a predetermined threshold, i.e., the attention image judged to be similar to the reference image, is obtained according to this invention, the attention image will be displayed as a static image on a display. Both testers can diagnose by comparing the attention image and reference image which are a static image.
[0018]
[Embodiment of the Invention] Drawing 1 is the block diagram of the outline of the ultrasonic diagnostic equipment which is the suitable operation gestalt of this invention. This equipment can generate for example, an B mode fault image. If a timing signal is outputted from the timing signal generator 10, the scan controller 12 will output a scan control signal to the transceiver machine 14. Thereby, a driving pulse is supplied from the transceiver machine 14 in a predetermined transmitting cycle period to a probe 16. An ultrasonic pulse is emitted by this driving pulse from a probe 16 in the living body, and the supersonic wave reflected in the living body is received with a probe 16. A probe 16 is constituted including a trembler array and the input signal outputted from each trembler is sent to amplifier 17 through the transceiver machine 14 for every channel. After predetermined magnification is performed by this amplifier 17, an input signal is changed into a digital signal in the A/D (analog to degital) transducer 18, the input signal for every channel is compounded by wave-receiving phasing processing in the beam formation machine 19, and a receiving beam is formed. The input signal outputted from the beam formation machine 19 is detected in a wave detector 20. And it is sent to DSC (digital scan converter)24 as fault image information. This DSC24 has an image composition function, an image interpolation function, etc. On the other hand, the input signal outputted from the amplitude computing element 22 branches, and is inputted also into the correlation index operation part 30. That is, the data of the attention fault image based on the echo data obtained on current and real time using the probe 16 are inputted into DSC24 and the correlation index operation part 30.
[0019] On the other hand, the fault image obtained by the past diagnosis etc. is stored in the storage section 32. The fault image (reference fault image) read from the storage section 32 with the above-mentioned attention fault image is inputted into the correlation index operation part 30.
[0020] The correlation index operation part 30 calculates the correlation index with which similar extent of these attention fault image and a reference fault image is expressed quantitatively. The computed correlation index is inputted into the comparison test section 34. The threshold about a correlation index is set to the comparison test section 34. The comparison test section 34 judges that both the above-mentioned images are fully similar, when a correlation index is beyond the threshold concerned. The decision result is used in DSC24 and the storage section 32 so that it may mention later.
[0021] Now, after what the user chose among modification of a hue or processing processing called profile emphasis in the image data processing section 36 is given to the reference fault image read from the storage section 32, it is inputted into DSC24. DSC24 generates the overlay image on top of which this reference fault image and the attention fault image inputted from the amplitude computing element 22 were laid. The digital image data outputted from DSC24 is changed into an analog signal by the D/A-converter (degitalto analog) converter 38, and is displayed on a display 40.
[0022] Drawing 2 is a mimetic diagram explaining the structure of the B mode fault image obtained by this equipment. The image field of the sector obtained by sector electronic raster scanning is shown in this drawing. Each point in this image field is specified in a group with line number i (0 <=i<=N) which shows the direction of the index j (0 <=j<=M) which shows the distance (depth) from an ultrasound

probe, and electronic raster scanning.
[0023] Both the attention fault image piled up by this invention and a reference fault image have the image field shown in drawing 1 </A> . Each pixel on an attention fault image and each reference fault image is specified by the index (i, j). Here, the brightness information of the pixel as which the brightness information of the pixel specified in the group (i, j) of the index on an attention fault image is specified in the group (i, j) of the index on data [i], [j], and a reference fault image is expressed with the notation data' [i] and [j]. Moreover, the color information on an attention fault image and each reference fault image is also specified as every [of an index] group (i, j).
[0024] With this equipment, an attention fault image and a reference fault image are piled up DSC24. It is that the group of an index displays that equal pixels pile up both images on the point on the same screen in an attention fault image and a reference fault image here. That is, DSC24 adds the pixel data same with the attention fault image of a sector configuration with the equal group of an index with the reference fault image of a sector configuration, and generates an overlay image. This addition processing is performed about brightness information and each color information.
[0025] Now, generally the fault image outputted from the amplitude computing element 22 is expressed by the monochrome image. The reference fault image is also saved as a monochrome image only with brightness information in the storage section 32. When an attention fault image and a reference fault image are piled up and displayed on the same field with monochrome image which was able to be obtained at the beginning, a user has a possibility that it may become impossible to identify both images, from the display image. So, with this equipment, predetermined image data processing is performed to a reference fault image by the image data processing section 36, and the image resulting from the attention fault image expressed by the overlay image and the image of each other resulting from a reference fault image are made identifiable.
[0026] One of the image data processing processings which the image data processing section 36 can perform is modification of a hue. That is, a color is given to the monochrome reference fault image read from the storage section 32. Moreover, as other processing processings, they are modification of the brightness of the whole image, profile emphasis processing in which the brightness of the edge of an image is changed, processing in which binarization of the brightness value is carried out based on a predetermined threshold, etc. These processings may be chosen by assignment of a user. It is also possible to make the multiple selection of those processings. For example, combination, such as modification of both a hue and brightness, hue modification, profile emphasis and hue modification, and binarization, is selectable.
[0027] Incidentally, the image needed for a diagnosis is an attention fault image, and, on the other hand, a reference fault image is chiefly used for positioning of an attention fault image. That is, since it is enough if the rough structure of an image is known about a reference fault image, attaining simplification of an image by binarization processing does not interfere, and it also has the merit that control of amount of information and mitigation of the processing load accompanying it are achieved on the contrary.
[0028] The reference fault image processed in this image data processing section 36 and the attention fault image from the amplitude computing element 22 pile up in DSC24. In addition, a reference fault image is a still picture and an attention fault image is an animation fundamentally. In addition to data processing by the above-mentioned image data processing section 36, the difference about the existence of this time amount change also has the effectiveness which makes discernment of both images easy.
[0029] In addition, although binarization processing of a reference fault image is performed in the image data processing section 36 here, it is good also as carrying out, before storing this in the storage section 32. With such a configuration, in the storage section 32, the reference fault image by which binarization was carried out will be saved, and the capacity of the reference fault image occupied in the storage section 32 can be controlled.
[0030] Next, count and its use of the correlation index of the attention fault image and reference fault image in this equipment are explained. With this equipment, the correlation coefficient R about brightness information is calculated as a correlation index. This correlation coefficient R is calculated by

the degree type.
[0031]
[Equation 1]

$$R = \frac{\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}(data[i][j]-\overline{data})\cdot(data'[i][j]-\overline{data'})}{\sqrt{\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}(data[i][j]-\overline{data})^2\cdot\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}(data'[i][j]-\overline{data'})^2}}$$

$$\overline{data} = \frac{1}{NM}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}data[i][j],\quad \overline{data'} = \frac{1}{NM}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}data'[i][j]$$

In addition, it may replace with [the brightness information data [i] and j], data' [i], and [j] of each image, and a correlation coefficient R may be calculated using the data which carried out binarization of them with the predetermined threshold.
[0032] The exclusive OR of each pixel with the reference fault image which carried out binarization to the attention fault image which carried out binarization is used for other examples of an index which can be used as a correlation index. By this approach, the value which integrated the exclusive OR of each pixel about the whole image can be used as a correlation index. The image which reversed one image, and one of other images are because it becomes complementary and the addition value within the image of an exclusive OR also becomes large along with it as extent of coincidence of both images becomes high.
[0033] In addition, it is good also as evaluating matching of both images based on a well-known image processing. For example, the profile of an image is extracted from each of both images, and there is a method of comparing these profiles and performing image matching. Moreover, the texture analysis of both the images is carried out, the characteristic quantity of both images is extracted, and there is also a method of comparing them.
[0034] Thus, calculation of a correlation index judges whether based on it, the comparison test section 34 of both images corresponds (or it is in tolerance and similar). The threshold according to the correlation index adopted is set to the comparison test section 34. The range of the correlation coefficient R adopted here is -1<=R<=1, and a threshold is set as the forward value 0.8.
[0035] The comparison test section 34 outputs signals, such as a pulse, when R exceeds a threshold. DSC24 freezes an overlay image, when the output pulse from this comparison test section 34 is detected. That is, the image of the attention fault image currently expressed as the animation in the overlay image till then is made to stand it still. This does not lay the attention fault image by which a sequential input is carried out from the amplitude computing element 22 on top of a reference fault image, but when the pulse from the comparison test section 34 is detected, it is realized by repeating the synthetic image of an attention fault image and a reference fault image, and making it display on a display 40.
[0036] Moreover, the storage section 32 will capture and record the attention fault image outputted to corresponding time of day from the amplitude computing element 22, if the pulse from the comparison test section 34 is received.
[0037] These friezes function and an image incorporation function are useful to compaction of diagnostic time amount while mitigating the load of the user for detecting the coincidence condition of an attention fault image and a reference fault image. While a user is going to make an attention fault image in agreement with a reference fault image and the sense and contact location of a probe 16 are changed variously by trial and error, the condition of considering as the purpose both whose screens correspond by chance may arise. However, in such a case, it is also difficult for the probe 16 to already have moved to other conditions from the target condition in many cases, when the user has recognized coincidence, and to reproduce the condition of the coincidence. In such a case, it is effective, when

coincidence arises, equipment judges it automatically, and maintains and displays the overlay image at that time on a display 40, and each above-mentioned function captures and records the attention fault image at that time on the storage section 32. A user can diagnose based on the attention fault image stored in the image maintained by the display 40 or the storage section 32. By this, since the user also of a possibility of it not being necessary to judge a coincidence condition by oneself, and overlooking it is lost, a probe 16 can be operated quickly, the time amount to discovery of a coincidence condition will be shortened, and the time amount which a diagnosis takes will be shortened.

[0038] The correlation index computed by the correlation index operation part 30 can also be constituted so that it may display on a display 40 numerically. Referring to the numeric value displayed with an overlay image, since it can location or be suitable, it can pass and a probe 16 can be moved, a user can search such a configuration for the target condition which it increases efficiently. Moreover, the means by which it is special as a display means of a correlation index in addition to display 40 can also be used. For example, it is also possible to display with the indicator on CRT from which the display number changes according to the size of a correlation index. With this configuration, a user can grasp intuitively whenever [attention fault image's obtained from condition of present probe 16 coincidence].

[0039] In addition, the storage section 32 can use various kinds of data storage means, such as a frame memory, a magnetic disk drive, and VTR. Moreover, the correlation index operation part 30, the comparison test section 34, and the image data processing section 36 can also be constituted using hardware, and software can also constitute them.

[0040] Moreover, the above, generation of an overlay image, and processing of calculation of a correlation index are performed synchronizing with the control signal (not shown) from the timing signal generator 10.

[0041]

[Effect of the Invention] As explained above, according to this invention, the effectiveness that the comparison with an attention image and a reference image becomes easy is acquired an attention image and a reference image piling up and being displayed as one overlay image, or by showing extent of coincidence with an attention image and a reference image as an objective correlation index. The effectiveness that it becomes easy to operate an ultrasound probe is acquired so that the image from the cross section which was in agreement with the past reference image, or a view may be obtained by this. Moreover, it becomes easy to grasp aging, such as condition of disease of a diagnostic part, correctly by coincidence of the cross section obtained by making it such or a view or the similar comparison of both images, and the reliable ultrasonic diagnosis of it becomes possible.

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TECHNICAL FIELD

[Field of the Invention] Especially this invention relates to the ultrasonic diagnostic equipment which can perform the comparison with the past observation result about an ultrasonic diagnostic equipment.

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PRIOR ART

[Description of the Prior Art] In the diagnosis by the ultrasonic image, the same part is compared among different patients, and investigating aging of the same patient's disease is performed. In order to enable a useful comparison in these cases, it is necessary to obtain the ultrasonic image in the same tomographic layer. It depends for the tomographic layer scanned by the supersonic wave not only on the location to which an ultrasound probe is applied but on the sense of the transmission-and-reception wave of a supersonic wave.
[0003] It is a difficult activity to inspect by making the same the degree of freedom of these plurality of a probe each time, and it is an activity which requires skill. While displaying the ultrasonic fault image (reference fault image) obtained by the past inspection with a still picture on the display screen of an ultrasonic diagnostic equipment as a policy which solves this difficulty, how to arrange to it and display the attention fault image which is an ultrasonic fault image under current inspection can be considered. Comparing two fault images on a screen, the tester who is a diagnostic-equipment user will change the contact location and sense of an ultrasound probe, and will search this approach for the conditions from which a desired fault image is obtained. According to this approach, the standard which judges whether it is that with which a tester can be satisfied of the conditions of a current ultrasound probe is obtained.

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EFFECT OF THE INVENTION

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TECHNICAL PROBLEM

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[0005] This invention is made in view of the above-mentioned conventional technical problem, and the purpose is in making it easy to obtain an attention fault image with the value as a candidate for a comparison in the ultrasonic diagnostic equipment which diagnoses based on the comparison with a reference fault image.

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MEANS

[Means for Solving the Problem] The ultrasonic diagnostic equipment concerning this invention contains an overlay image generation means generate the overlay image on top of which a reference image storage means memorize the reference image based on the echo data of the past obtained by the transmission-and-reception wave of a supersonic wave, an attention image generation means generate an attention image based on the echo data obtained now, and said reference image and said attention image of each other laid identifiable, and a display means display said overlay image.
[0007] According to this invention, the attention image made applicable to diagnostic piles up with the reference image obtained in the past diagnosis, is set, and is displayed. A reference image is an image set as the comparison object of an attention image. The class will not be asked if an attention image and a reference image are images of the same kind. That is, for example, they may be a solid image besides a fault image, an M mode image, etc. Moreover, generally an attention image is not restricted in that case, although generated based on the newest echo data in the time of a diagnosis usually being performed. That is, current [of "the echo data obtained now" about an attention image / "current"] means the time of considering as the candidate for diagnostic, and means that it is at the separate diagnostic time as the echo data of a reference image here. According to the overlay image on top of which the reference image and the attention image were laid, a tester is shown both images unitary and it becomes easy for a tester to grasp the existence of a difference of both [these] images and extent.
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[0011] The ultrasonic diagnostic equipment concerning this invention contains a reference image storage means memorize the reference image based on the echo data of the past obtained by the transmission-and-reception wave of a supersonic wave, an attention image generation means generate an attention image based on the echo data obtained now, and a correlation evaluation means compute the correlation

index of said reference image and said attention image.
[0012] According to this invention, the difference with a reference image and an attention image is quantitatively shown as a correlation index. A tester can adjust the contact location of an ultrasound probe, and the sense so that the correlation index may decrease. As a correlation index, although a correlation coefficient can be used, it is not necessarily restricted to it, for example.
[0013] In the ultrasonic diagnostic equipment of the suitable mode of this invention, it has the binarization means which carries out binarization of said reference image and said attention image, respectively, and said correlation evaluation means computes said correlation index of said reference image by which binarization was carried out, and said attention image by which binarization was carried out. The value which integrated with the value of the exclusive OR for every pixel of both images in the image field in addition to the correlation coefficient can be used as a correlation index in this mode.
[0014] The suitable mode of this invention has a profile extract means to extract a profile from said reference image and said attention image, respectively, and said correlation evaluation means is an ultrasonic diagnostic equipment which computes said correlation index based on the comparison between said profiles extracted from said reference image and said attention image, respectively.
[0015] Moreover, the ultrasonic diagnostic equipment concerning other this inventions is characterized by having an index display means to display said correlation index. According to this invention, the tester using equipment is shown a correlation index and a tester can judge similar extent of an attention image and a reference image based on the correlation index. For example, the digital readout of the correlation index can also be carried out on an image display device with an attention image, and it can also be displayed with the indicator displayed on CRT.
[0016] The ultrasonic diagnostic equipment concerning this invention is characterized by detecting that said correlation index exceeded the predetermined threshold, and having an image storing means to store said attention image in a storage means. According to this invention, the attention image which has a correlation index beyond a predetermined threshold, i.e., the attention image judged to be similar to the reference image, is recorded automatically. A tester can read the recorded attention image from a storage means, and can perform the diagnosis based on the comparison with a reference image etc.
[0017] The ultrasonic diagnostic equipment concerning this invention is characterized by detecting that said correlation index exceeded the predetermined threshold, and having an image frieze means to freeze said attention image whose animation is displayed by the display. If the attention image which has a correlation index beyond a predetermined threshold, i.e., the attention image judged to be similar to the reference image, is obtained according to this invention, the attention image will be displayed as a static image on a display. Both testers can diagnose by comparing the attention image and reference image which are a static image.
[0018]
[Embodiment of the Invention] Drawing 1 is the block diagram of the outline of the ultrasonic diagnostic equipment which is the suitable operation gestalt of this invention. This equipment can generate for example, an B mode fault image. If a timing signal is outputted from the timing signal generator 10, the scan controller 12 will output a scan control signal to the transceiver machine 14. Thereby, a driving pulse is supplied from the transceiver machine 14 in a predetermined transmitting cycle period to a probe 16. An ultrasonic pulse is emitted by this driving pulse from a probe 16 in the living body, and the supersonic wave reflected in the living body is received with a probe 16. A probe 16 is constituted including a trembler array and the input signal outputted from each trembler is sent to amplifier 17 through the transceiver machine 14 for every channel. After predetermined magnification is performed by this amplifier 17, an input signal is changed into a digital signal in the A/D (analog to degital) transducer 18, the input signal for every channel is compounded by wave-receiving phasing processing in the beam formation machine 19, and a receiving beam is formed. The input signal outputted from the beam formation machine 19 is detected in a wave detector 20. And it is sent to DSC (digital scan converter)24 as fault image information. This DSC24 has an image composition function, an image interpolation function, etc. On the other hand, the input signal outputted from the amplitude computing element 22 branches, and is inputted also into the correlation index operation part 30. That is,

the data of the attention fault image based on the echo data obtained on current and real time using the probe 16 are inputted into DSC24 and the correlation index operation part 30.
[0019] On the other hand, the fault image obtained by the past diagnosis etc. is stored in the storage section 32. The fault image (reference fault image) read from the storage section 32 with the above-mentioned attention fault image is inputted into the correlation index operation part 30.
[0020] The correlation index operation part 30 calculates the correlation index with which similar extent of these attention fault image and a reference fault image is expressed quantitatively. The computed correlation index is inputted into the comparison test section 34. The threshold about a correlation index is set to the comparison test section 34. The comparison test section 34 judges that both the above-mentioned images are fully similar, when a correlation index is beyond the threshold concerned. The decision result is used in DSC24 and the storage section 32 so that it may mention later.
[0021] Now, after what the user chose among modification of a hue or processing processing called profile emphasis in the image data processing section 36 is given to the reference fault image read from the storage section 32, it is inputted into DSC24. DSC24 generates the overlay image on top of which this reference fault image and the attention fault image inputted from the amplitude computing element 22 were laid. The digital image data outputted from DSC24 is changed into an analog signal by the D/A-converter (degitalto analog) converter 38, and is displayed on a display 40.
[0022] Drawing 2 is a mimetic diagram explaining the structure of the B mode fault image obtained by this equipment. The image field of the sector obtained by sector electronic raster scanning is shown in this drawing. Each point in this image field is specified in a group with line number i (0 <=i<=N) which shows the direction of the index j (0 <=j<=M) which shows the distance (depth) from an ultrasound probe, and electronic raster scanning.
[0023] It has the image field indicated to be the attention fault image piled up by this invention, and a reference fault image to both drawing 1 . Each pixel on an attention fault image and each reference fault image is specified by the index (i, j). Here, the brightness information of the pixel as which the brightness information of the pixel specified in the group (i, j) of the index on an attention fault image is specified in the group (i, j) of the index on data [i], [j], and a reference fault image is expressed with the notation data' [i] and [j]. Moreover, the color information on an attention fault image and each reference fault image is also specified as every [of an index] group (i, j).
[0024] With this equipment, an attention fault image and a reference fault image are piled up DSC24. It is that the group of an index displays that equal pixels pile up both images on the point on the same screen in an attention fault image and a reference fault image here. That is, DSC24 adds the pixel data same with the attention fault image of a sector configuration with the equal group of an index with the reference fault image of a sector configuration, and generates an overlay image. This addition processing is performed about brightness information and each color information.
[0025] Now, generally the fault image outputted from the amplitude computing element 22 is expressed by the monochrome image. The reference fault image is also saved as a monochrome image only with brightness information in the storage section 32. When an attention fault image and a reference fault image are piled up and displayed on the same field with monochrome image which was able to be obtained at the beginning, a user has a possibility that it may become impossible to identify both images, from the display image. So, with this equipment, predetermined image data processing is performed to a reference fault image by the image data processing section 36, and the image resulting from the attention fault image expressed by the overlay image and the image of each other resulting from a reference fault image are made identifiable.
[0026] One of the image data processing processings which the image data processing section 36 can perform is modification of a hue. That is, a color is given to the monochrome reference fault image read from the storage section 32. Moreover, as other processing processings, they are modification of the brightness of the whole image, profile emphasis processing in which the brightness of the edge of an image is changed, processing in which binarization of the brightness value is carried out based on a predetermined threshold, etc. These processings may be chosen by assignment of a user. It is also possible to make the multiple selection of those processings. For example, combination, such as

modification of both a hue and brightness, hue modification, profile emphasis and hue modification, and binarization, is selectable.

[0027] Incidentally, the image needed for a diagnosis is an attention fault image, and, on the other hand, a reference fault image is chiefly used for positioning of an attention fault image. That is, since it is enough if the rough structure of an image is known about a reference fault image, attaining simplification of an image by binarization processing does not interfere, and it also has the merit that control of amount of information and mitigation of the processing load accompanying it are achieved on the contrary.

[0028] The reference fault image processed in this image data processing section 36 and the attention fault image from the amplitude computing element 22 pile up in DSC24. In addition, a reference fault image is a still picture and an attention fault image is an animation fundamentally. In addition to data processing by the above-mentioned image data processing section 36, the difference about the existence of this time amount change also has the effectiveness which makes discernment of both images easy.

[0029] In addition, although binarization processing of a reference fault image is performed in the image data processing section 36 here, it is good also as carrying out, before storing this in the storage section 32. With such a configuration, in the storage section 32, the reference fault image by which binarization was carried out will be saved, and the capacity of the reference fault image occupied in the storage section 32 can be controlled.

[0030] Next, count and its use of the correlation index of the attention fault image and reference fault image in this equipment are explained. With this equipment, the correlation coefficient R about brightness information is calculated as a correlation index. This correlation coefficient R is calculated by the degree type.

[0031]

[Equation 1]

$$R = \frac{\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}(data[i][j]-\overline{data})\cdot(data'[i][j]-\overline{data'})}{\sqrt{\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}(data[i][j]-\overline{data})^2\cdot\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}(data'[i][j]-\overline{data'})^2}}$$

$$\overline{data} = \frac{1}{NM}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}data[i][j],\quad \overline{data'} = \frac{1}{NM}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}data'[i][j]$$

In addition, it may replace with [the brightness information data [i] and j], data' [i], and [j] of each image, and a correlation coefficient R may be calculated using the data which carried out binarization of them with the predetermined threshold.

[0032] The exclusive OR of each pixel with the reference fault image which carried out binarization to the attention fault image which carried out binarization is used for other examples of an index which can be used as a correlation index. By this approach, the value which integrated the exclusive OR of each pixel about the whole image can be used as a correlation index. The image which reversed one image, and one of other images are because it becomes complementary and the addition value within the image of an exclusive OR also becomes large along with it as extent of coincidence of both images becomes high.

[0033] In addition, it is good also as evaluating matching of both images based on a well-known image processing. For example, the profile of an image is extracted from each of both images, and there is a method of comparing these profiles and performing image matching. Moreover, the texture analysis of both the images is carried out, the characteristic quantity of both images is extracted, and there is also a method of comparing them.

[0034] Thus, calculation of a correlation index judges whether based on it, the comparison test section 34 of both images corresponds (or it is in tolerance and similar). The threshold according to the correlation index adopted is set to the comparison test section 34. The range of the correlation

coefficient R adopted here is -1<=R<=1, and a threshold is set as the forward value 0.8.
[0035] The comparison test section 34 outputs signals, such as a pulse, when R exceeds a threshold. DSC24 freezes an overlay image, when the output pulse from this comparison test section 34 is detected. That is, the image of the attention fault image currently expressed as the animation in the overlay image till then is made to stand it still. This does not lay the attention fault image by which a sequential input is carried out from the amplitude computing element 22 on top of a reference fault image, but when the pulse from the comparison test section 34 is detected, it is realized by repeating the synthetic image of an attention fault image and a reference fault image, and making it display on a display 40.
[0036] Moreover, the storage section 32 will capture and record the attention fault image outputted to corresponding time of day from the amplitude computing element 22, if the pulse from the comparison test section 34 is received.
[0037] These friezes function and an image incorporation function are useful to compaction of diagnostic time amount while mitigating the load of the user for detecting the coincidence condition of an attention fault image and a reference fault image. While a user is going to make an attention fault image in agreement with a reference fault image and the sense and contact location of a probe 16 are changed variously by trial and error, the condition of considering as the purpose both whose screens correspond by chance may arise. However, in such a case, it is also difficult for the probe 16 to already have moved to other conditions from the target condition in many cases, when the user has recognized coincidence, and to reproduce the condition of the coincidence. In such a case, it is effective, when coincidence arises, equipment judges it automatically, and maintains and displays the overlay image at that time on a display 40, and each above-mentioned function captures and records the attention fault image at that time on the storage section 32. A user can diagnose based on the attention fault image stored in the image maintained by the display 40 or the storage section 32. By this, since the user also of a possibility of it not being necessary to judge a coincidence condition by oneself, and overlooking it is lost, a probe 16 can be operated quickly, the time amount to discovery of a coincidence condition will be shortened, and the time amount which a diagnosis takes will be shortened.
[0038] The correlation index computed by the correlation index operation part 30 can also be constituted so that it may display on a display 40 numerically. Referring to the numeric value displayed with an overlay image, since it can location or be suitable, it can pass and a probe 16 can be moved, a user can search such a configuration for the target condition which it increases efficiently. Moreover, the means by which it is special as a display means of a correlation index in addition to display 40 can also be used. For example, it is also possible to display with the indicator on CRT from which the display number changes according to the size of a correlation index. With this configuration, a user can grasp intuitively whenever [attention fault image's obtained from condition of present probe 16 coincidence].
[0039] In addition, the storage section 32 can use various kinds of data storage means, such as a frame memory, a magnetic disk drive, and VTR. Moreover, the correlation index operation part 30, the comparison test section 34, and the image data processing section 36 can also be constituted using hardware, and software can also constitute them.
[0040] Moreover, the above, generation of an overlay image, and processing of calculation of a correlation index are performed synchronizing with the control signal (not shown) from the timing signal generator 10.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of the outline of the ultrasonic diagnostic equipment which is the suitable operation gestalt of this invention.
[Drawing 2] It is a mimetic diagram explaining the structure of the B mode fault image obtained by this equipment.
[Description of Notations]
10 A timing signal generator, 12 A scan controller, 14 A transceiver machine, 16 A probe, 24 DSC, 30 Correlation index operation part, 32 The storage section, 34 The comparison test section, 36 The image data processing section, 40 Display.

[Translation done.]

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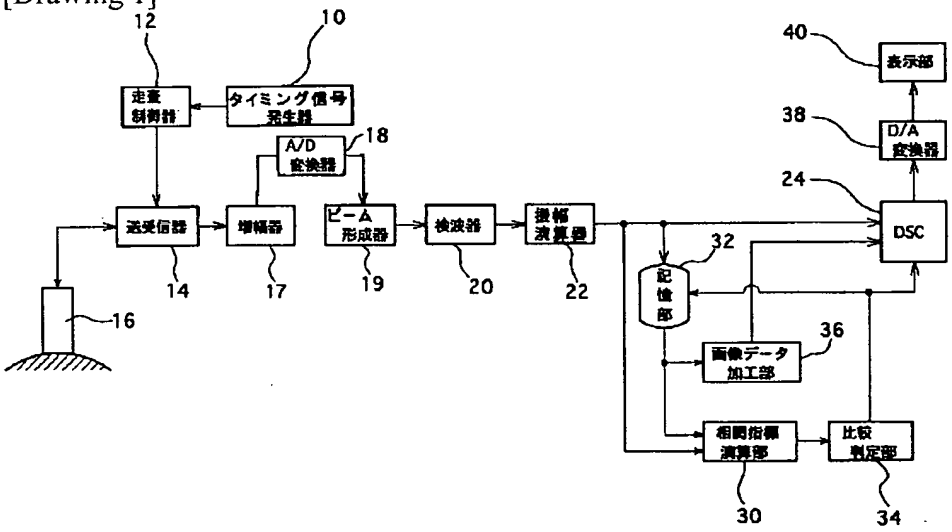
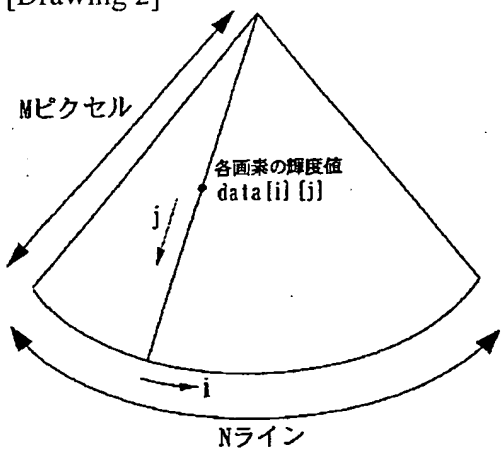
DRAWINGS

[Drawing 1]



[Drawing 2]



[Translation done.]